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No. LXXV.

Defcription of a Speedy Elevator. By the Inventor, NICHOLAS COLLIN, D. D. *with two drawings from a model, reprefenting it folded and wound up.*

Read before the Society, and the Model prefented, on the 2d December 1791; honoured with the Magellanian gold Medal in December 1795.

THE main body of the bafe is a rectangular folid floor. (Fig. F. W. in the plate.) To its corners are jointed four horizontal legs, of equal thicknefs with it, but half the length, having their nether fides even with its bottom. When the machine is ufed, thefe are difplayed fo that their ends form a rectangle; the diagonals of which may be on thofe of the main body, or vary from them in a pofition moft promotive of ftability.

The pillars A A ftand vertical on the long diameter of the bafe, equally diftant from its ends. Their feet enter into it, and are by the ftrongeft faftening incorporated with its body. Thefe pillars are pairs. Their form is a rectangular parallelipiped. Their inner fides have grooves from top to bottom: which terminate by offsets in cylindric fegments. Near the tops are central embrazures, whofe fides are fortified with iron plates that reach within the folid parts above and below. The pulleys are of metal, with fteel axes and brafs naves for eafy turning, and deep channels for fecuring the cords.

The pillars are joined by three pairs of ribs. Thefe are rectangular; wide, but comparatively thin; placed horizontally, between the tops and embrazures, about the middles, and near the feet. Their ends are clofely fitted within the pillars, and well faftened.

The piers B B are more flender than A A; with fhorter heads; but the length of their bodies is equal to the whole

whole of theſe.* They have ſimilar grooves, embrazures, pulleys, and joining ribs. Their faces are parallel rectangles. The backs of their bodies have tongues along the middles that fit the grooves of A A. Theſe are vertical rectangular ridges, and parts of the very pieces, formed by cutting down both ſides to a proper level. Theſe lower ſurfaces, being even and ſmooth, will thus move cloſe along the correſponding plain parts of AA while the tongues glide in contact with the ſides of the grooves.

The cords *a a* are well paired in length and texture. They ply over the pulleys of A A in the ſaid hollows behind the grooves; having their ends fixed under the feet of B B, and on the boxes of the windlaſs. This is well ſecured in the baſe, cloſe to and right beneath the pillars.

The cords *b b* are faſtened by one end on the heads of A A. They paſs over the pulleys of B B, and reach as far below them as *a a* reach below the pulleys of A A, which is the diſtance of theſe pulleys from the baſe. Their other ends are tacked a little above the bottoms of the piers C C.

Theſe piers are with their apparatus framed like B B; have leſs bulk and ſhorter heads. Their pulleys clear the tops of B B when the machine is down.

The cords *c c* have the ſame length with *b b*, below the pulleys of C C; plying over theſe; faſtened on the heads of B B and ſomewhat above the bottom of the pier D.

This is a ſingle piece. It has two backs to fit the grooves of C C, formed like the backs of the other pieces.

A frame is accurately fixed and poiſed on the top of D. In this the load L is placed, ſo that its centre of gravity is exactly or very nearly over the centre of the frame.

When the power begins to wind the cords *a a*, theſe raiſe the piers B B. As they riſe, their pulleys recede from the tops of A A, and by ſtretching the cords *b b* lift the piers C C. Theſe recede at the ſame time from the tops of

* I call the part about the embrazure *neck*, that above *head*, and that below *body*.

of B B, and lift the pier D. Thus while B B are wound up from the baſe to the height of the pulleys of A A, D riſes treble that height; and however great may be the number of moving pieces, it multiplies the celerity and acquired elevation of the uppermoſt by that of the firſt.

As the duration and celerity of all the movements is the ſame, the lengths of all the cords below the reſpective pulleys muſt be equal.

As the whole acquired elevation is by thoſe parts of the piers which are drawn out of their folds, theſe ought to have a very great proportion. Therefore B B reach the baſe when down; and the heads of A A are but long enough to keep them ſafe in their grooves, when drawn up. Again, as the ends of the cords *b b* will be above the baſe according to the length of the heads of A A, the heads of B B are ſhortened, and the bodies of C C are prolonged below thoſe ends, in order to ſave room, and yet afford theſe piers a ſecure depth in the grooves of B B, when drawn up. On the ſame principle the heads of C C are ſhortened, and a part of D left under the ends of *c c*. As theſe additions of ſaid pairs cannot increaſe the elevation, the cords ought to be fixed above them in order to ſhorten the bearings, and ſo far make the bodies firmer. In a longer ſeries of piers this ſhortening of the heads can only be continued to the limit of depth neceſſary to ſupport the ſtrains.

The pier D preſſes the cords *c c* by its own weight, and the load L. This preſſure cauſes an equal pulling and conſequential reſiſtance in the tops of the piers B B. The pulleys of the piers C C muſt bear this double preſſure $= 2\,L + 2\,D$. Theſe therefore preſs the cords *b b* with ſaid weight and their own $= 2\,L + 2\,D + C\,C$. This doubled $= 4\,L + 4\,D + 2\,C\,C$ is the preſſure on the pulleys of B B: But their heads are pulled up by $L + D$: The difference of theſe forces added to their own weight is the

preſſure of theſe piers on the cords *a a*, = 3 L + 3 D + 2 CC + B B. The power on the windlaſs muſt be equal to this.

In any ſeries the power muſt lift a weight equal to the firſt piers, double the ſecond, and ſo forth, till the laſt pier and its load multiplied by the number of moving pieces.

The pulleys, cords, and ribs have ſome weight, and are to be counted as parts of their reſpective piers. A competent allowance is likewiſe required for the friction of the pulleys, which impedes the aſcent, though the deſcent is advantageouſly retarded by it.

The preſſure on the pulleys of the pillars A A is double the power. The ſtrain in their tops is half of the weight on the pulleys of B B. The difference of theſe forces, = 4 L + 4 D + 3 C C + 2 B B, added to their own weight is the preſſure on the baſe.

The ſtrain in the tops of any piers in a ſeries is equal to what the power would be, if the pair next above was the laſt. The weight on the pulleys of the ſame pair is double the ſtrain in the tops of the pair next below. The ſtrain on their feet is equal to the ſtrain in the tops of the piers two ranks below.

It is very neceſſary to compute the ſtrains and preſſures in order to ſecure all the parts, and to ſave needleſs bulk, which would be a great diſadvantage in the piers by the additional expenſe of power. The preſſure of vertical pieces by their own weight muſt be counted, though not as equal to the ſame quantity of external burden laid upon them: its operation is viſible in high maſſive beams, which bend without any load; but in ſhort though ſlender pieces it is not ſufficient to break the internal coheſion of the parts. The effect of external weight is according to its quantity, and to the height and ſlimneſs of the piers; but not in uniform proportions. Divers kinds of wood have alſo different degrees of weight, and of vertical firmneſs: ſome are both ſtiff and light to an admirable degree: piers made

made of these can under slender forms bear weights many times greater then their own. These qualities are in their blended effects of different value in this machinery: the pillars are the most pressed, but they cause no weight to the power, and therefore their bulk is the less detriment. B B being the heaviest laden piers are the most solid, but they have only a simple moment: C C bearing less are lighter, but their moment is double: D has a treble moment, but the lightest burden, and thus the least weight of its own. These continually growing increments of solidity are necessary consequences of the constant double bearings; but ought to be small in comparison to the pressures thus produced, which become very great, when the load to be lifted, and the elevation are considerable. Lightness is then most beneficial in the upper ranks, and firmness in the lower, as *these must lift but those be lifted* many times: accordingly different sorts of wood may be chosen by their degrees of lightness and firmness; they being otherwise proper, especially for close and smooth folding.

On account of the grooves and tongues the pieces cannot have those regular forms that give the greatest solidity; nor can the pulleys be placed exactly over the line of central strength. In practise these defects must not exceed necessary limits. Moreover, when the pressures and strains on the several parts of the pieces are estimated, hollows may be contrived in places that can bear it—These niceties cannot be marked in a model.

When the load, the elevation, and quality of the wood are given, the lightest series of piers is found by computing the results from different numbers.* A greater number must effect a greater proportion of the whole elevation than a smaller, because the pillars, by becoming shorter, contribute less; this addition is a new expense of power. The

* In this the pairs are considered as one.

weight of the load is eſſential, as it muſt be multiplied by the whole number of piers; imparts the ſame moment to its own pier of competent bulk; and in conjunction with it thickens with continual increaſe all the others. On the other hand the firmneſs of piers increaſes greatly with the decreaſe of their height within certain limits. Some ſpecies of wood have alſo correſponding degrees of ſtrength. The co-operation of theſe advantages may therefore render a conſiderable number of ſhort piers light, and proportionally ſo in their reſpective multiple moments. The more numerous the piers are, the ſooner is the machine wound up, and let down, which is an advantage, ſo far as men can make greater exertions for a ſhort time.

The form of the windlaſs determines, in combination with the preceding, the ſpeed of operation, and the degree of power. It admits various modes: for example, one might be placed on either ſide of the pillars, with long handles on the winches; by which eight men can work together. This model is intended to ſhow conſiderable effects from an eaſy apparatus: accordingly two men lift another, and three tiers of piers: they are aided by a ſufficient projection of the winches beyond the ſemidiameter of the boxes: this has ſuch proportion to the height of the pulleys in the pillars, and the equal length of the cords *a a* below them, that the whole winding is done by a few turns. The dimenſions of the piers are not ſpecified, as my experiments are not ſufficient; but I eſtimate them ſo, that the elevation is at leaſt fifty feet. The power increaſes, though the velocity decreaſes by leſſening the width of the boxes; and this can be done while their length can ſo correſpond, that the rounds of the cords *a a* have ſufficient room, when the machine is wound up:

Oblique

Oblique preſſures cannot ariſe from the principles of conſtruction; but happen from inevitable imperfection of materials and workmanſhip in a ſmall degree, which is not an object of exact calculation, but ſhould have full allowance for its effects on the machine. The obliquity will be the greater as the folding is ſhallow, and the fitting is looſe. The effect reſults jointly from the angle of declination, the length of the pier, and its moment of weight. The oblique bearings on the ends of the tongues, when the machine is wound up will be dangerous, if theſe have not a competent ſolidity.

All the piers with their moments of weight bear on the pillars; and the preſſure on their pulleys is the difference between double the power and the ſtrain of their heads, which balance is very great. This preſſure remains there when the machine is wound up, in every ſtage of the elevation, however great. The common centre of gravity of the pulleys thus preſſed, the pillars themſelves, and the baſe, is below the pulleys. Thus the machine has a great ſtability, and the baſe is accordingly not extenſive.

This machine combines theſe advantages: ready approach to heights otherwiſe not acceſſible without great trouble: ſpeedy aſcent and deſcent: convenient folding for keeping under cover, and for eaſy conveyance. It can be applied to ſeveral uſeful purpoſes:—Quick hoiſting and lowering of things on many occaſions; particularly ſaving of goods from upper ſtories in caſes of incend: High elevation and ſpeedy exchange of ſignals: theſe being light may be raiſed three hundred feet, and above interjacent hills: Elevation of a perſon for taking views, and quick deſcent when required; as on reconnoitring an enemy within ſhot: a machine calculated for lifting him at leaſt one hundred feet by eight men can be light enough for carrying on a waggon by two horſes.